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INHERITANCE OF BIOLOGICAL YIELD AND DEVELOPMENTAL TRAITS IN CHICKPEA

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ABSTRACT

The nature and magnitude of genetic variances controlling biological yield and developmental traits *viz.*, days to flowering, maturity period, plant height and branches per plant was worked out in F_1 and F_2 generations of a 5 x 5 half diallel in Chickpea. Both graphic and component analyses revealed overdominance with non-allelic interactions for biological yield, and branches per plant, while partial to complete dominance for days to maturity and complete to slightly overdominance for maturity period and plant height with predominance of additive gene effects was observed. Biparental mating in certain selected crosses has been suggested for exploiting the additive as well as non- additive gene effects simultaneously.

KEY WORDS : Chickpea, inheritance, gene action, component analysis

Many of the breeding research are restricted to improvement in grain yield and its direct components such as number of pods, grains per pod and grain weight etc. As the development of these final yield components depends upon initial vigour and vegetative growth of the plants, biological yield (total dry matter) assumes importance. In the present studies an attempt has been made to study the inheritance of biological yield and some of the developmental traits through diallel analysis which will help in choosing the appropriate breeding methodology for Chickpea improvement.

MATERIALS AND METHODS

Five diverse and elite chickpea varieties *viz.*, Phule G 5, Annegiri, Early Gulab, Selection-436 and Chafa were crossed in all possible combinations (excluding reciprocals) to get a set of diallel crosses. The diallel progenies, 10 F_1's, 10 F_2's and five parents were sown in randomised block design with three replications during *rabi*, 1992. Each plot of parents, F_1's and F_2's had two, single and 10 rows of 4.5 m length, respectively, spaced at 30 cm. Spacing between plants within row was 15 cm. Recommended cultural practices were followed to raise a good crop.

Days to flowering, maturity period, plant height (cm), branches per plant and biological yield (total dry matter at maturity excluding root system and fallen leaves) per plant (g) were recorded on randomly selected five competitive plants from each of the parental and F_1 plots and 50 plants from each of F_2 plots (excluding border plants). Plot means were used for statistical analysis. Analysis of variance (Panse and Sukhatme, 1967), the graphic and component analyses of F_1 diallel crosses (Jinks, 1954 ; Hayman, 1954) the estimates of various genetic parameters in F_2 generation (Jinks, 1956) and the phenotypic and genotypic correlation co-efficients were worked out between grain yield, biological yield and other characters in F_2 populations of the diallel cross.

RESULTS AND DISCUSSION

The analysis of variance showed highly significant genotypic differences among the treatments (parents, F_1's and F_2's) for all the characters in both the generations except for number of branches in F_2. The "t^2" values given in table 2 were non- significant for all the characters in both the generations indicating that the assumptions proposed by Hayman (1954) on which diallel analysis is based are fulfilled.

Graphic Analysis

The linear regressions of Wr against Vr (Wr-Vr graphs), the limiting parabola (Wr^2 = Volo.Vr) and the scatter of parental points along the regression lines for all the characters in F_1 generation are presented in Fig.1.

The regression lines for biological yield and branches per plant intersected the Wr axis well below the origin point suggesting over doiminance. Regression line intersected the Wr axis just below the origin point for maturity period and plant height suggesting complete or slightly over dominance,

Table 1. Estimates of genetic components of variation for various characters in F_1 and F_2 generations of 5 x 5 diallel in Chickpea

Components	Biological yield per plant		Days to flowering		Maturity period		Plant height		Branches per plant	
			F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
D	33.52	51.47*	67.30**	70.62**	15.38**	15.25*	19.88**	21.73**	9.07	18.13**
	±62.73	±11.10	±5.09	±8.35	±1.27	±3.96	±1.96	±1.57	±13.50	±1.66
H_1	266.00	173.40	33.39	528.90**	16.24*	125.10	12.10	21.11	117.70*	13.65
	±169.41	±119.92	±13.74	±90.17	±3.42	±42.76	±5.28	±16.94	±36.47	±17.97
H_2	221.40	135.20	27.50	496.20**	13.26*	87.93	15.16	23.72	87.31	16.84
	±153.66	±108.77	±12.46	±81.78	±3.10	±38.78	±4.79	±15.37	±33.08	±16.30
h^2	175.97	42.43	-1.30	362.27**	3.70	21.01*	21.09**	29.02**	68.83	-0.68
	±103.74	±18.36	±8.41	±13.80	±2.09	±6.55	±3.23	±2.59	±22.33	±2.75
F	-131.80	-62.21	35.93	98.01	11.52*	46.04	-6.41	17.92	-45.42	-2.13
	±156.70	±55.46	±12.71	±41.70	±3.16	±19.78	±4.89	±7.83	±33.78	±8.31
E	31.71	13.77	5.58	2.20	2.36*	2.44	6.52**	4.55	16.93	7.86**
	±25.61	±4.53	±2.08	±3.41	±0.52	±1.62	±0.80	±0.64	±5.51	±0.68

*, ** Significant at P = 0.05 and P = 0.01 respectively

where as it intersected the Wr axis above the origin point for days to flowering suggesting partial dominance for this character. Regression Co-efficients for biological yield and branches per plant deviated significantly from unity indicating the presence of non-allelic interactions for these characters. Genic interactions for plant weight (Zafar and Khan, 1968) and branches per plant (Zafar and Abdulla, 1971) were reported by earlier workers. Such genic interactions, however, were absent for remaining characters as the regression co-efficients for them did not deviate significantly from unity indicating the predominance of additive type of gene action. The widely scattered parental array points indicated wide genetic diversity among the parents for the characters studied.

Considering the distribution of array points along with regression line parents can be classified into two groups. Selection-436, Chafa and Annegiri possessed higher propörtion of dominant alleles for most of the characters. These parents, however, did have higher proportion of recessive alleles for one or more characters. Selection-436 had slightly higher proportion of recessive alleles for maturity period. Chafa had maximum recessive alleles for branches per plant and Annegiri for plant height and biological yield. The other group of parents consisted of Early Gulab and Phule G 5 which had higher proportion of recessive alleles for all the characters except that they were having almost equal proportion of dominant and recessive alleles for biological yield and plant height, respectively.

Component Analysis

The components of genetic variance for various characters in F_1 and F_2 generation are given in Table 1. The estimates of additive genetic variance (D) were either significant or highly significant for all the traits in both the generations except for biological yield and branches per plant in F_1 generation. The two measures of dominance components namely, H_1 (dominance effect) and H_2 (proportion of dominance due to positive (u) and negative (V) effects of genes) were significant for maturity period (F_1) and highly significant for days to flowering (F_2). H_1 was also significant for branches per plant in F_1 generation. The third measure i.e. h^2 (net-dominance effect expressed as the algebraic sum over all loci in heterozygous phase in all crosses) was significant for maturity period and highly significant for days to flowering (F_2) and plant height (F_1, F_2). The dominance components (H_1 and H_2) for biological yield though non significant were higher in magnitude than the corresponding additive component (D) in both F_1 and F_2 generations. These findings, therefore, revealed the importance of both additive and dominance effects for the characters under study.

The estimates of F which indicated the relative frequency of dominant and recessive alleles in the parents were negative for biological yield and branches per plant in both the generations indicating an excess of recessive alleles governing these traits. The positive values for days to flowering and maturity period (significant in F_1)

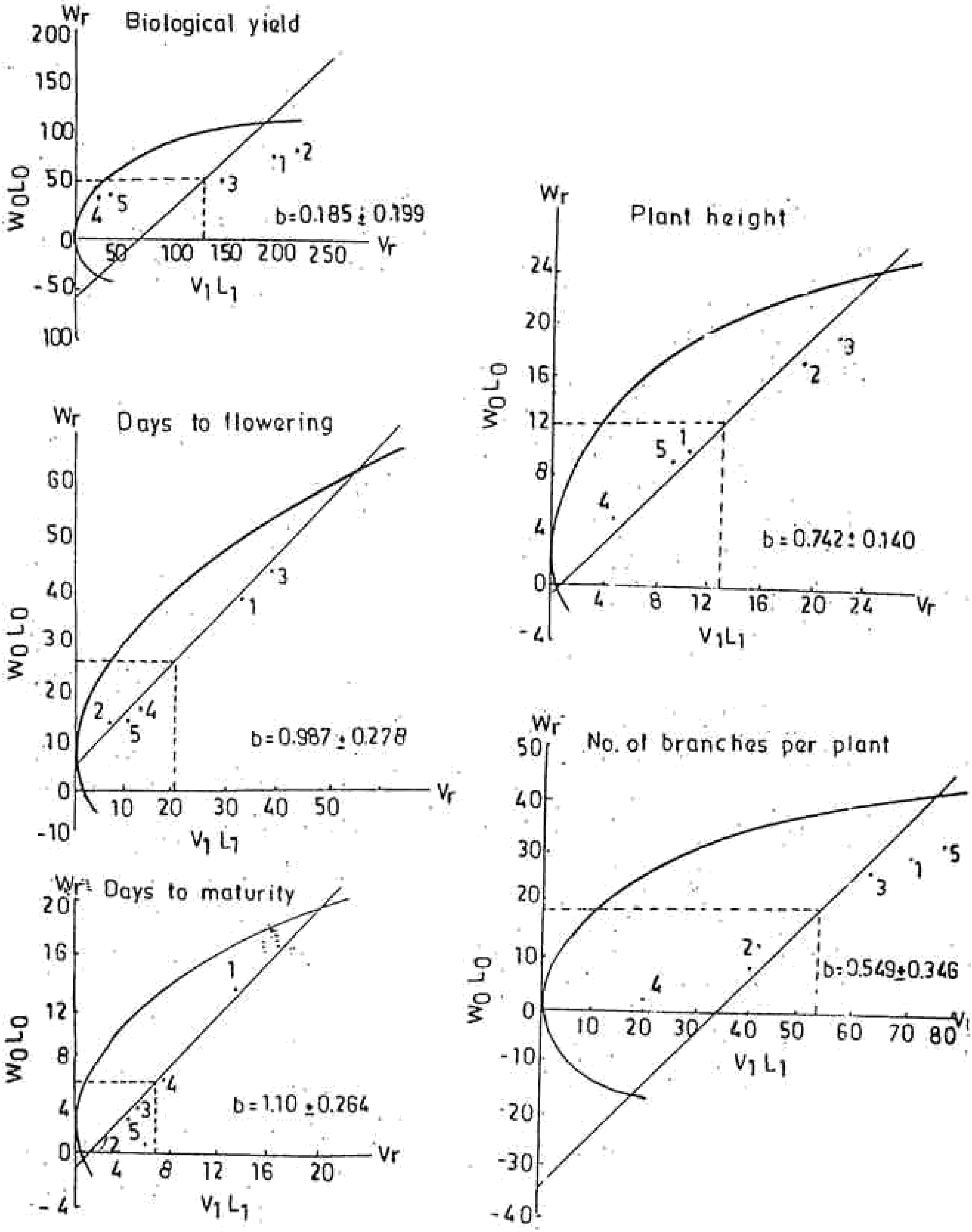

Fig. 1. Regression of Wr on Vr in F1 diallel

Table 2. Proportions of the genetic components of variation and "t^2" values for various characters in F_1 and F_2 generations of 5 x 5 diallel crosses in chickpea

	Biological yield per plant		Days to flowering		Maturity period		Plant height		Branches per plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
$(H_1/D)^{0.5}$	2.82	1.84	0.71	2.74	1.03	2.86	0.78	0.99	3.60	0.87
$H_2/4H_1$	0.21	0.19	0.20	0.23	0.20	0.18	0.31	0.28	0.19	0.31
$(4DH_1)^{0.5}+F$ / $(4DH_1)^{0.5}-F$	0.18	0.50	2.21	1.68	2.15	3.23	0.66	2.44	0.18	0.87
h^2/H_2	0.79	0.31	-0.05	0.73	0.28	0.24	1.39	1.22	0.79	0.04
r (Wr+Vr) Yr	0.35	-0.56	0.39	-0.94	0.87	0.10	0.14	0.54	0.57	0.94
b W/Vr	0.19	0.69	0.99*	0.61*	1.10*	1.04	0.74*	0.73	0.55	0.89*
	0.20	0.23	0.28	0.13	0.24	1.03	0.14	0.39	0.35	0.25
Y^2	4.48	0.59	0.14	5.09	0.65	2.49	1.93	0.00	0.24	0.00

* Significant at P = 0.05

indicated higher proportion of dominant alleles for these traits, while, F values for plant height were negative in F_1 and positive in F_2, this may be due to equal proportion of dominant and recessive alleles for this character.

The relative proportions of the genetic components have been presented in Table 2. The estimates of degree of dominance $(H_1/D)^{0.5}$ were higher than unity for biological yield and branches per plant in F_1 indicating over dominance which were reduced in F_2 as expected because of breaking down of 50 per cent heterotic combinations leading to 50 per cent homozygosity. Over dominance for branches per plant was reported by Dhaliwal and Gill (1973). These estimates were almost equal to unity for maturity period (F_1) indicating complete or slightly over dominance and were less than unity for days to flowering and plant height in F_1 which suggested partial to complete dominance. The estimates for degree of dominance for days to flowering, maturity period and plant height increased in F_2 which confirmed the predominance of additive gene effects revealed from graphic analysis. Additive gene action for days to flowering was reported by Dhaliwal and Gill (1973) and for plant height and maturity period by Asawa and Tiwari (1976).

$H_2/4H_1$ ratio indicated an assymetric distribution of positive and negative alleles for all the characters except that the value was some what close to 0.25 for days to flowering in F_2. The relative proportions of dominant and recessive alleles for different characters as revealed from positive or negative F values were confirmed by the ratio $(4DH_1)^{05}+F/4DH_1)^{0.5}-F$. The estimates h^2/H_2 were not very effective in indicating the number of genes or groups exhibiting dominance for the characters.

The estimates of phenotypic and genotypic correlation co-efficients given in Table 3 indicated highly significant positive correlation of grain yield with biological yield, days to flowering, plant height and branches per plant at genotypic level.

Table 3. Estimates of phenotypic (p) and genotypic (G) correlations between grain yield, biological yield and developmental traits in F_2 generation of 5 x 5 diallel cross in chickpea

Characters		Biological yield per plant	Days to flowering	Maturity period	Plant height	Branches per plant
Grain yield per plant	P	0.960**	0.541	0.079	0.619	0.702*
	G	0.977**	0.772**	0.197	0.837**	0.957**
Biological yield per plant	P	-	0.455	0.096	0.518	0.737*
	G	-	0.651*	0.380	1.000**	0.892**
Days to flowering	P	-	-	0.071	0.541	0.367
	G	-	-	-1.000**	1.000**	0.789*
Maturity period	P	-	-	-	-0.351	0.139
	G	-	-	-	0.599	0.146
Plant height	P	-	-	-	-	0.547
	G	-	-	-	-	0.993**

*, ** Significant at P = 0.05 and P = 0.01 respectively

Significant positive association among the characters except maturity period suggests the possibility of yield improvement in Chickpea by similtaneous selection for these characters. Maturity period did not show significant positive association with any of these characters indicating that higher biological yield and grain yield can be combined with optimum duration in chickpea.

Considering both the analyses, graphic and component, it is concluded that both additive as well as non-additive (including epistasis) genetic variances were important for all the characters. Non-additive component was more important in the inheritance of biological yield and number of branches per plant. Considering the importance of these two characters for yield improvement in Chickpea, breeding a homozygous stable line by pedigree method would mean only a partial exploitation even of the additive genetic variance. Under such a situation for exploitation of both, additive and non-additive genetic variances and also for the breeding of broad based widely adopted varieties in certain elite crosses as indicated by Deshmukh (1980), population breeding approach in the form of biparental mating between selected recombinants as well as mating of selected segregants between crosses in early segregating generations should be practiced.

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EFFECT OF CEMENT KILN DUST POLLUTION ON SOIL PROPERTIES AND ON SORGHUM PLANTS

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ABSTRACT

The effects of cement kiln pollution on *sorghum bicolor* has been studied. Simulated pollution by dusting on experimental plants in different quantities was compared with non-dusted control plants. The dusted plants showed a reduction in leaf area index, plant height, stem girth, grain yield and dry matter production. These parameters of the lowest dose of dust (2.5 g m^{-2}) were almost comparable with that of the control plots. Further increase in the dosage showed an adverse effect on crop growth and yield. The amount of total chlorophyll, chlorophyll 'a' and 'b' and soluble protein was found to derease on dusting. However, dose of 2.5 g m^{-2} was comparable with control plot in all the cases. The dusted plants showed a decrease in N and P content and an increase in K, Ca and Na. In the soil, available N and P contents reduced, while available K content increased in the dusted plots when compared to that of the control plots. The dose of 2.5 g m^{-2} did not show any significant change in the contents. Therefore, it was concluded that upto 2.5 g m^{-2} dose of cement kiln dust, there is no significant effect on the crop, beyond which there is an adverse effect on crop growth and yield.

KEY WORDS : Pollution, cement kiln dust, sorghum, soil